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Yellow-cedar Decline

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YELLOW-CEDAR DECLINE

Decline and mortality of yellow-cedar is the most spectacular forest problem in southeast Alaska. Yellow-cedar (*Chamaecyparis nootkatensis*), sometimes called Alaska-cedar, is the principal victim in this decline. Other tree species are largely unaffected. Yellow-cedar has extremely valuable wood; thus the problem has considerable economic impact. This tree species also has ecological importance and its wood and bark have long been used by Native people. Decline occurs in forests that have not been visibly altered by timber harvesting or other human disturbance. While the ultimate cause of yellow-cedar decline is still a mystery, this pamphlet provides information on the appearance of dying trees, describes the distribution of decline, highlights studies on possible disease organisms and ecological factors, and introduces ideas on possible causes.

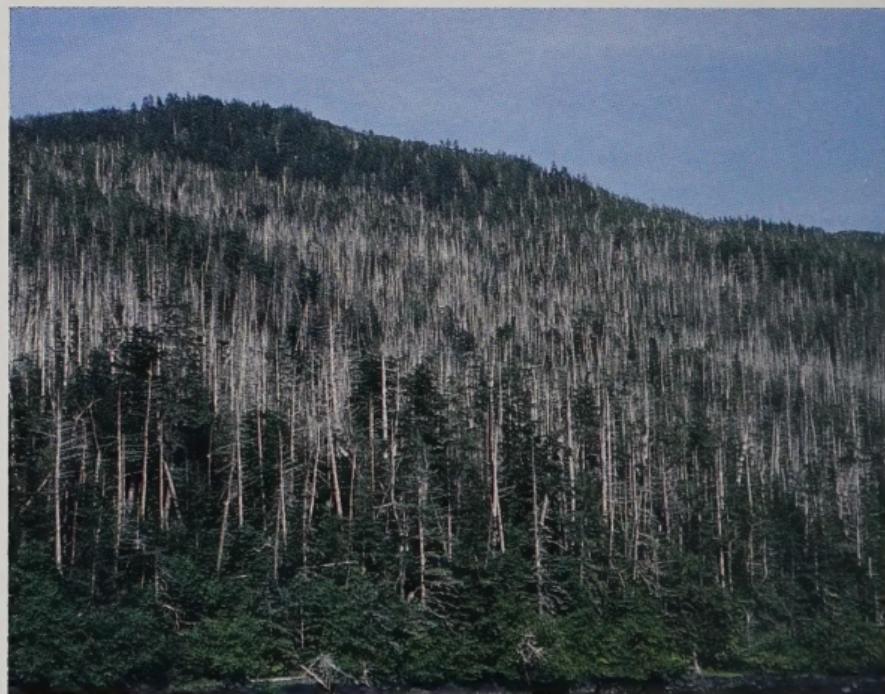


Figure 1. Stand suffering intense mortality of yellow-cedar on western Chichagof Island.

Appearance of decline.

From a distance, forests suffering from yellow-cedar decline appear white or light grey due to the numerous dead trees (Fig. 1). These areas of dead trees can be as small as one acre or very expansive and contiguous covering miles along hillsides. A closer look reveals that most of the dead trees are yellow-cedars and even the ones that have been dead for many decades have pointed, unbroken tops. This appearance distinguishes them from other tree species which are more susceptible to wood decay and break off after being dead for a number of years. Yellow-cedar wood has a pleasant, characteristic smell that can be used to identify it long after tree death. On average, two-thirds of mature yellow-cedar trees are dead in areas of declining forests. Typically, declining yellow-cedar forests are composed of a dense concentration of dead yellow-cedars, some that died recently, others long ago; a smaller number of yellow-cedars that are currently dying; and some green trees of various species, including yellow-cedar (see cover photograph).

Declining cedar trees have a number of visible symptoms leading to death. Trees sometimes die quickly (e.g., 2-3 years) where crowns are full, but red or brown (Fig. 2). Other trees die much more slowly with crowns thinning for 15 years or more before death. Declining trees rarely, if ever, recover. Regardless of how rapidly crowns die, their root systems are always in an advanced stage of deterioration by the time crown symptoms appear. Death of the smallest roots is often the first indication that a tree is beginning to die of decline, followed by larger roots that die, and then death of inner bark in vertical streaks along the tree bole.

Once a cedar tree dies, it generally remains standing long after death, in some documented cases for more than a century!



Figure 2. Dying yellow-cedar tree.

Distribution of decline.

We have mapped the various locations of cedar decline from aircraft during the last decade (Fig. 3). More than 500,000 acres of decline have been identified in southeast Alaska. Decline is absent or not serious to the south in British Columbia or to the northwest towards

the limits of yellow-cedar's range in Prince William Sound. Within southeast Alaska, the decline problem is common in forests where yellow-cedar is abundant on sites with poor moisture drainage at low or middle elevations. The common occurrence at remote and pristine locations indicates that cedar decline is a naturally-occurring phenomenon. Many of these areas are also visible from the air or water routes taken by tour ships or ferries where many people notice the poor condition of the forest and ask what's wrong.



Figure 3. General distribution of dying yellow-cedar forests in southeast Alaska.



Figure 4. Secondary organisms, such as Phloeosinus bark beetles (galleries appear above knife) and the fungus Armillaria (mycelial fans below knife), are common on dying cedars but are not capable of killing unstressed trees.

Studies on disease organisms.

Our research has focused on organisms that are associated with dying cedars and could be the primary cause of tree death. We have found more than 50 species of fungi (Fig. 4), several insects and nematodes, and other organisms on dying cedars, but none has shown the capability of killing healthy seedlings or trees. Several fungi and bark beetles are weakly aggressive and probably speed the death of some trees, however. The primary cause now appears to be some non-living factor, probably associated with poorly drained soils.

In some areas, brown bears cause substantial damage to yellow-cedar trees each spring by tearing off the bark on their lower boles (Fig. 5). More than one half of cedars in some forests have this form of bole wounding, but its occurrence is independent from decline.



Figure 5. Brown bears cause substantial wounding to yellow-cedar trees each spring in some forests, but this activity is not the cause of forest decline.

Ecological studies.

Our studies on the ecological aspects of cedar decline suggest that extensive tree mortality began a little over 100 years ago in about

1880. Our evidence also suggests that decline began at about the same time on all sites where it now occurs -- thus it has not spread to any new sites since onset. The boundaries of decline have spread slightly at some sites, but typically by not more than 300 feet in the last century. Where decline has spread locally, its spread has been out of bogs (muskegs) upslope to trees growing on somewhat better drainage. Cedar decline is highly specific to certain sites, characterized by having poor drainage. Less commonly, cedar decline occurs on steeper hillsides where soils are very shallow and underlaid by bedrock. But yellow-cedar trees growing with other conifers on more productive sites with better drainage away from bogs have not experienced cedar decline. We predict that the problem will not develop in such forests.

The ages of most trees that die are in the range of 100-400 years old with some considerably older. These ages do not represent old age for a species such as yellow-cedar that has great potential longevity -- well over 1,000 years. We are currently studying the natural succession that is occurring on sites impacted with decline. As most of the yellow-cedar dies in the overstory while other tree species are less affected, yellow-cedar stands appear to be giving way to forests dominated by western hemlock and mountain hemlock.

Possible causes.

Our studies suggest that cedar decline is naturally-occurring and is caused by some environmental stress. Possible stresses include soil toxins and freezing damage. Organic toxins could result from natural anaerobic decomposition in the wet, highly organic soils

where decline is so common. Perhaps yellow-cedar is more sensitive to such toxins.

Alternatively, cold temperatures could damage the fine root systems of yellow-cedar trees because roots are very shallow and are left unprotected during periods of frigid weather in winter when there is no snowpack to provide insulation. The onset of cedar decline coincided with the beginning of a warming trend in Alaska. Perhaps insulating snowpacks were more consistent at low elevations during winters 100 years ago before the climate warmed slightly changing more winter precipitation from snow to rain. More research is needed to test these ideas and to determine if associated climate change is responsible as a triggering mechanism. The lack of any contagious agent causing cedar decline suggests that foresters can have confidence in managing this valuable species without threat of it spreading to sites that do not already have decline.

Cedar Regeneration.

At most decline locations, yellow-cedar is not reproducing successfully. To replace yellow-cedars lost by the forest decline and timber harvesting, the Tongass National Forest has initiated a program of seed collection, seedling production, and planting. We have been studying the survival and growth of planted yellow-cedar seedlings since 1986 on Etolin Island with the Wrangell Ranger District. When seedlings are planted in areas of adequate light and drainage, we found that they have excellent survival and early growth (Fig. 6). We are now experimenting with methods of attaining natural regeneration without planting by leaving mature trees as a source of seeds in harvested areas.



Fig. 6. Yellow-cedar sapling 6 years after planting for reforestation.

Conclusions.

There are different perspectives from which to think about yellow-cedar decline. One is the commercial loss and potential salvage opportunities of a very valuable tree species. Another is the loss of a tree that yields materials used by local people. The loss of yellow-cedar in declining forests may also represent a reduction in biological diversity as yellow-cedar gives way to the more common hemlock forests. Some biologists view cedar decline as the slow passing of one species from an ancient family of trees (the cedars and cypresses). Clearly, yellow-cedar decline is a naturally-occurring phenomenon -- its early onset in about 1880 and occurrence in remote

and pristine areas suggest that it has developed independently from human activities. As the story of yellow-cedar decline unfolds, it may provide a valuable lesson of the demise of a forest type under conditions where human involvement is minimal. Thus, it may help us to understand that forests are naturally dynamic and are always undergoing change even in areas largely unaffected by humans.

We are not alone in our efforts to try and solve the puzzle of forest decline. There are several dozen tree declines in different forests scattered all over the world; for almost all, scientists have not assigned adequate explanations as to their causes. Summarized below is some of what we do know about yellow-cedar decline.

- ▶ Covers more than 500,000 acres
- ▶ Occurs on wet poorly drained sites at lower and middle elevations
- ▶ Principle victim is yellow-cedar, a tree species which has ecological, cultural, and economic importance
- ▶ Many organisms are associated with dying cedars, but none is the primary cause
- ▶ Began about 100 years ago, apparently without subsequent long-distance spread
- ▶ Yellow-cedar is not reproducing effectively on many sites
- ▶ Some declining cedar forests are converting to hemlock-dominated forests
- ▶ Primary cause is still a mystery; researchers are currently investigating the role of soil and climate factors

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Yellow-cedar decline

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Additional information on this forest problem or any forest insect or disease can be obtained from:

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